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Demographic Changes and Economic Growth in Pakistan: Role of Capital Stock

ZAINAB JEHAN and FAIZA AZHAR KHAN

Pakistan has been experiencing a decrease in population growth since early 1990s which led to increasing the ratio of working age population known as demographic dividend. The demographic dividend may lead to higher savings and investment which resultantly spurs economic growth. Given this postulation, the study is first of its kind to empirically analyse the impact of demographic variables on economic growth through physical capital for Pakistan over the period 1960–2014. In this regard, the demographic change is captured by taking four alternate measures namely population growth, young age dependency ratio, old age dependency ratio and working age population ratio. In order to examine the channel effect, at the first step, the direct impact of demographic changes on physical capital is estimated. Later, the impact of demographically-induced capital stock is estimated on economic growth. By using the FMOLS technique, the study concludes that the total negative impact is highest in case of old age dependency which means that higher old age dependency is the most threatening demographic change for economic growth. The least harmful demographic change is the young age dependency. Moreover, the empirical findings highlight the importance of capital stock as the mediating channel in the demographic change and economic growth relationship. The study recommends effective long-term policies to increase youth employment and to enhance savings for maximising the benefits of demographic dividend.

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Keywords: Direct and Indirect Impact, Demographic Transition, Demographic Age Structure, Capital Stock, FMOLS

1. INTRODUCTION

Demographic changes have long been emphasised as vital in explaining the economic growth of a country. Over the course of time, researchers have debated on the probable impact of demographic changes (with particular emphasis on population change and birth rates as indicators of demographic change) on economic/income growth being negative, positive or neutral as explained by the pessimistic, optimistic and neutralism schools, respectively. Pessimistic view focused on the capital dilution effect, the dependency effect and the savings effect being plausible explanations for the negative relationship between population growth and income growth. The *Capital dilution* effect also known as the *Solow effect* entails that increase in population increases the number of

Zainab Jehan and Faiza Azhar Khan <faiza.fjwu@gmail.com> are Assistant Professors at the Department of Economics, Fatima Jinnah Women University, The Mall, Rawalpindi.
Authors' Note: All correspondence may kindly be directed to the second author on email: faiza.fjwu@gmail.com.

labours and consequently reduces the capital per worker. Similarly, the dependency effect and the savings effect encompass larger number of dependents and lower savings resulting from increasing birth rates respectively [Malthus (1798); Coale and Hoover (1958); Kelley (1988); Barro (1991); Brandner and Dowrick (1994); Todaro and Smith (1994); Ahituv (2001); Lee and Mason (2010)]. However, according to Ashraf, *et al.* (2013), the dependency effect is dominant in the initial decades while the capital dilution effect becomes important in the later years.

On the contrary, underlining the importance of economies of scale and human capital stock due to increase in population, the optimistic view documented positive impact of population growth on the economic performance [Boserup (1965); Srinivasan (1988); Kuznets (1960); Simon (1981)]. According to the optimists view, increasing population can also help reduce the diminishing returns arising from an aging population [Coale and Hoover (1958); Meier (1995)]. Furthermore, Boserup (1965) suggested that rising population creates incentives for innovations in technology and institutions. Finally, the third and recent view is neutralism which concluded little or no significant impact of population growth on economic growth in the presence of other control variables [Bloom and Freeman (1986); Kelley (2001); Bloom and Williamson (1998)].

However, the above mentioned literature on the relationship between population growth and economic growth has ignored an important aspect of changing age structure of population. Despite similar population growth, age structures can be different which consequently have varying impacts on economic growth [Bloom, *et al.* (2001)]. Countries with relatively more young and old age populations may experience lower economic growth because of the requirement of huge expenditures on their education and health. In contrast, countries with a high proportion of working age population have better economic performance. The varying population age structure is a result of changing fertility and mortality rates over time which can further be linked to the demographic transition of countries. In the current phase of the demographic transition, most of the developing countries of the world are experiencing declining mortality and fertility rates which may result in increasing the share of working age population in total population [Batini, *et al.* (2006)]. This offers an opportunity of demographic dividend to these countries provided countries are focusing on the education and health of this young cohort of population and also the labour market has the capacity to absorb these young labours productively [Bloom, *et al.* (2001); Bloom and Finlay (2009)]. Demographic dividend affects the economic performance of a country through increased labour supply, higher savings, and investments in human capital; all of which have considerable positive impact on economic growth. It is worth noting that the demographic dividend is also rendered as one of the contributory factors in the East Asian growth miracle [Bloom and Williamson (1998)].

As mentioned above, there is considerable amount of literature which focuses on the direct impact of various indicators of demographic changes on economic growth. However, the impact of demographic changes on economic growth is not only direct but also conditional on various channels such as physical capital, employment and human capital. It is therefore important to analyse how and to what extent the impact of demographic changes on economic growth varies through these channels. A voluminous literature on economic growth has rendered various factors necessary for economic

growth, namely, physical capital, human capital, inflation rate, government consumption ratio, trade openness, institutional quality, democracy and the life expectancy etc. [Sala-i-Martin (1997); Sala-i-Martin, *et al.* (2004)]. Since the Harrod-Domar and Solow models of economic growth, physical capital is considered as one of the most important determinants of economic growth for any country. Mankiw, *et al.* (1992) and Barro and Sala-i-Martin (2004) in their famous studies on empirics of economic growth have also underscored the significance of physical capital for economic growth. Therefore, we have selected physical capital stock as the mediating factor in the relationship of demographic change and economic growth.

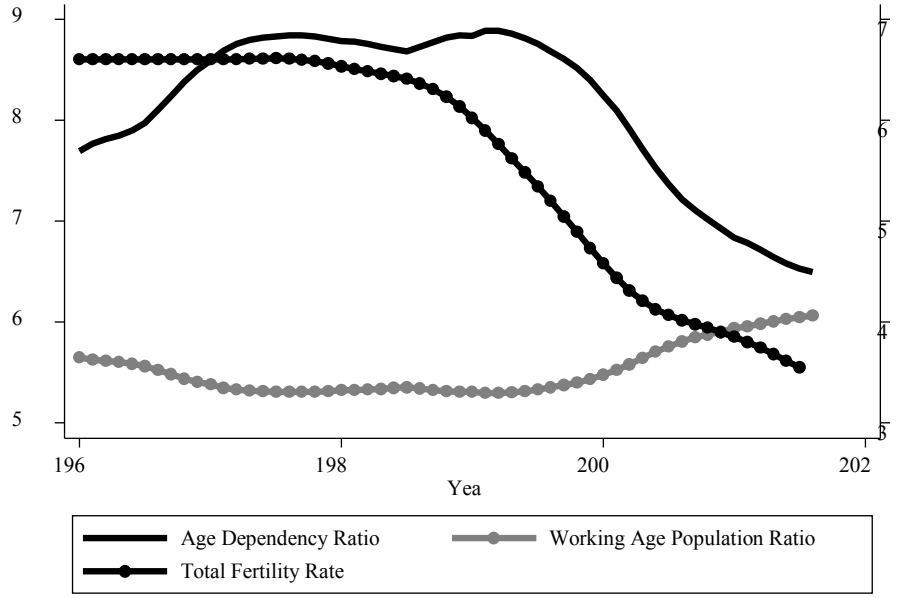
Interestingly, scholars have pondered on the mechanics of the impact of demographic variables on physical capital. To begin with, the life cycle model of savings and investment assert that household decisions about savings and investment depend on their age along with their income [Modigliani and Brumberg (1954)]. Goyal (2004) is of the view that decisions about portfolio investment are also a function of age. Further two hypotheses elucidating the relationship between investment and age namely; *life cycle investment hypothesis* and *life cycle risk aversion hypothesis* were contributed by Bakshi and Chen (1994). The former explains that as people get older their equity investment increases; while the latter documents that an increase in average age results in an increase in risk premium. The study by Batini, *et al.* (2006) concluded that an increase in population and labour force result in an increase in investment through both changes in marginal product of capital and consumption, and saving decisions. Using the overlapping generation model (OLG), d'Albis (2007) corroborated a non-monotonic relationship between demographic changes and capital accumulation owing to the opposite signs of capital dilution effect and savings effect.

Pakistan presently is going through demographic transition and the ratio of working age population is increasing while the dependency ratios are declining [see Figure 1]. The crude birth rate (CBR) were high in 1970s and early 1980s but reached to 30 births per 1000 population by the year 2006 and 29 births per 1000 population by the year 2015. Similarly, total fertility rate was 6.6 births per women in 1960 and 5 births per women in 1997, but declined to 3.5 births per women in 2015 [World Bank (2017)]. As far as the crude death rate is concerned, the figure was 15 in 1970 and dropped to 7 in 2015. Resultantly, the age dependency ratios as percentage of working age population have declined from 88 in both 1980s and 1990s to 65 in 2015 [World Bank (2017)]. However, the annual population growth rate in Pakistan is approximately 2 percent for the last decade.

Figure 1 depicts a smoother decline in fertility rate as compared to the age dependency ratio. The latter after declining in the beginning of 1980s started increasing again and eventually showed a consistent decline from 1990s onwards. Parallel in time, the working age population ratio has shown a continuous increase. Moreover, since the beginning of 1980s the fertility rate has shown a sharp decline. Figure 1 explicates 1990s as the start of demographic dividend period for Pakistan. According to Durr-e-Nayab (2008), the duration of demographic dividend in Pakistan is from 1990 to 2045 with its peak around the year 2000.It is imperative to mention here the findings of the recent population census conducted in 2017 which reported a surprisingly high annual average population growth of 2.40 percent over the period 1998-2017 for Pakistan given the

previously reported population growth of around 2 percent for this period [Pakistan Bureau of Statistics 2018]. According to the world development indicators, this figure of population growth is parallel to the one in 1998. The age dependency ratios and the working age population ratio may be different and thus leading to a lower demographic dividend then expected according to the Figure 1. Therefore, it is pertinent to study the implications of demographic changes in Pakistan.

Figure 1: Demographic and Fertility Transition in Pakistan



The present study aims at analysing the impact of demographic indicators on economic growth of Pakistan. Though some of the earlier studies have analysed the issue for Pakistan e.g. Hussain, *et al.* (2009), Choudhry and Elhorst (2010) and Iqbal, *et al.* (2015). But, the present study in unique in its attempt to estimate the direct and indirect impact of demographic variables on economic growth through the channel of physical capital given the importance of physical capital in explaining economic growth. The study utilises the time-series data of Pakistan over the period 1960–2015 and applies FMOLS technique to estimate various models for measuring the direct and the indirect impact. Our empirical analysis is comprised of three steps. In the first step, the direct impact of demographic changes one economic growth is estimated by using four indictors of demographic change, namely, population growth, old age dependency ratio, working age population ratio, and young age dependency ratio. The second step is based on the computation of the indirect impact which involves (a) estimating the direct impact of each demographic indicator on capital stock separately; (b) the impact of demographically induced capital stock on economic growth is estimated; (c) the indirect

impact is computed by multiplying the coefficient of demographic change indicator (from a) with the respective capital stock coefficient (obtained from b). Finally, the total impact is computed by summing the direct and the indirect impacts.

2. LITERATURE REVIEW

Numerous studies have underlined the significance of demographic variables, i.e. working age ratio, young age dependency ratio, old age dependency ratio, in explaining economic growth and development [see Table A-1 for summary of literature review]. Malmberg (1994) has analysed the economic growth effects of changing age structures for Swedish economy over the period 1950–89 and concluded significant effects. Barro (1991) and Asian Development Bank (1997) in their cross-country growth regressions included growth rate of economically active population as an explanatory variable and concluded a positive impact. Later, Bloom and Williamson (1998) extended the analysis by also analysing the impact of growth rates of population of under age 15 and over age 64 together with growth rate of the dependent population on GDP per capita growth in separate regressions. Results have shown that population age under 15 has a negative and significant impact on income growth; however, the coefficient of population over age 64 is insignificant. In a study specifically focusing on Asian countries, Bloom, *et al.* (2001) ascribed most of the East Asian economic miracle to demographic transition and declining youth dependency ratios in these countries.

In a further study, Kelley and Schmidt (2005) reported a positive impact of working age population on growth rates of output per capita and output per worker for a sample of 86 developing countries over the period 1960-95. Authors have also included age dependency ratio, population size and density as alternative demographic regressors and have established that demographic change accounts for 20 percent of change in per capita income growth. In a recent study on implications of age structures for economic growth, Prskawetz, *et al.* (2007) have corroborated the negative impact of youth age dependency ratio on economic growth for a large panel of countries spanning over 1960-95. Similarly, Lindh and Malmberg (2009) analysed the relationship between different age structures and economic growth for EU-15 countries and concluded a hum-shaped relationship between age groups and GDP growth. In a related study Choudhry and Elhorst (2010) have also concluded negative impact of old and child age dependency ratios on per capita income growth for the period 1961–2003 for seventy countries. Further, the per capita income growth is also positive function of the difference between the working age population growth and total population growth.

As far as studies related to Pakistan are concerned, Hussain, *et al.* (2009) have analysed the impact of demographic variables on economic growth of Pakistan for the period 1972–2006. Both infant mortality rate and total fertility rate are having a negative impact on GDP growth of the country, while, growth rate of labour force has insignificant impact on economic growth. In another study, Choudhry and Elhorst (2010) concluded that population dynamics explain 25 percent of changes in per capita GDP growth in Pakistan. Finally, Iqbal, *et al*. (2015) has analysed the impact of demographic transition on economic growth of Pakistan over the period 1974-2011 and have reported positive impact of demographic transition on economic growth in the long-run but negative impact in the short-run.

Focusing on the relationship between population growth and savings, Park and Shin (2011) have supported a positive relationship between population and savings and argued that increase in population implies more workforce and hence more savings. This positive effect of population on savings is termed as the *growth effect* illustrating that higher population growth means more young population initially but more working age population later, thus leading to more savings. The opposite effect is known as the *dependency effect* which exemplified a negative relationship between population growth and savings owing to increased number of dependents [Prskawetz (2007)]. Finally, Asongu (2011) is of the view that increase in population growth may increase production through increases in consumption and labour supply. While, the opposite effect may also takes place owing to increase in unemployment and hence, the burden on the economy. Because, in latter situation, the investors are disappointed and they invest less.

Approaching to the empirical evidence on the relationship between demographic changes and physical capital, Malmberg (1994) has analysed the macroeconomic effects of changing age structure for Swedish economy over the period 1950-89 and concluded a hump shaped relationship between age group and savings. Some of the recent evidence on the relationship between demographic variables and physical capital has been extended by Goyal (2004), Bosworth and Chodorow-Reich (2006) and Batini, *et al.* (2006) and Asongu (2011). Goyal (2004) analysed the US data and concluded that demographic variables have important role in explaining the aggregate investment and savings. Forecasting the effect of demographic transition over next 80 years for USA, Japan and other developing countries, Batini, *et al.* (2006) corroborated a strong effect of demographic variables on savings, investment and capital flows. Using panel data of 85 countries over the period 1960–2005, Bosworth and Chodorow-Reich (2006) have documented a hump shaped relationship between age groups and savings. Finally, a significant long-run relationship between population growth and investment has been estimated by Asongu (2011) for 38 African countries over the period 1977–2007. However, the size of impact is different for public and private investments for various countries.

3. METHODOLOGY AND DATA

This study empirically examines the mediating role of physical capital stock in the relationship between demographic changes and economic growth. Alternatively, we intend to estimate the direct and indirect effects of demographic changes on economic growth by using the channel of physical capital stock. The empirical analysis, therefore, involves multiple steps. Firstly, for the direct impact, we estimate the effect of demographic changes on economic growth in the following model.

$$GDP_t = \alpha_0 + \alpha_1 K_t + \alpha_2 HK_t + \alpha_3 TO_t + \alpha_4 FDI_t + \alpha_5 CPI_t + \alpha_6 DV_t + \varepsilon_t \quad \ldots \quad (1)$$

where t = 1960 to 2015

Here, GDP_t is log of real gross domestic product, K_t is physical capital stock measured as log of real gross fixed capital formation, HK_t is human capital index based on years of schooling and returns to education, TO_t is trade openness measured as trade as percentage of GDP, FDI_t is foreign direct investment (net inflows) as percentage of GDP, CPI_t is log of consumer price index. DV_t is the particular demographic variable i.e.

PG_t, population growth (annual percentage), working age population as a percentage of total population i.e. WAPOP, $OADR_t$, old age dependency ratio as percentage of working-age population and $YADR_t$, young age dependency ratio as percentage of working age population. The model is estimated four times for these four different focused demographic variables.

The dependency ratio is expected to have an adverse impact on economic growth. Higher population growth put pressure on economic and financial resources and resultantly direct resources from investment towards consumption purposes [Kogel (2003)]. The impact of population growth on economic growth is viewed as positive by population optimists while negative by population pessimists. According to the pessimists, higher population growth creates pressure on economic resources and thus hampers accumulation of capital and hence decreases economic growth. On the other hand, the optimists identify that higher population growth generates more labour force, economies of scale and innovation and thus contributes towards economic growth. The working age population accelerates economic growth [An and Jeon (2006); Nguyen (2008); Bloom and Finlay (2009); Choudhry and Elhorst (2010)]. Because it provides labour, and also reduces dependency ratio thus ultimately contributes to economic growth [Choudhry and Elhorst (2010)]

Following Halkos and Paizanos (2014), the indirect impact is analysed in further two steps: Initially, the impact of demographic change on capital stock is estimated through model given in Equation (2). The estimated value of capital stock from the latter is labeled as "demographic-change-induced capital stock". Later, the impact of demographically induced capital stock on economic growth is estimated through model given in Equation (3).

$$K_t = \delta_0 + \delta_1 K_{t-1} + \delta_2 GDP_t + \delta_3 HK_t + \delta_4 r_t + \delta_5 FD_t + \delta_6 FDI_t + \delta_7 RER_t + \delta_8 G_t + \delta_8 DV_t + \xi_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

$$GDP_t = \gamma_0 + \gamma_1 K_t^{DV} + \gamma_2 HK_t + \gamma_3 TO_t + \gamma_4 FDI_t + \gamma_5 CPI_t + \gamma_6 FDI_t + \varsigma_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Where FD_t is financial development measured through domestic credit to private sector as percentage of *GDP,* RER_t is log of real exchange rate, G_t is government consumption expenditures as percentage of GDP and K_t^{DV} is demographic-change-induced capital stock estimated through Equation (2).

Demographic variables affect physical capital directly through investment while indirectly through the channel of savings. In this regard, life cycle theory supports the idea that saving decisions varies with age. Savings of young and old people are relatively less compared to the working age population. Moreover, a lower dependency ratio generally leads to higher savings by the working age group [Kogel (2003)]. Therefore, dependency ratio imposes an adverse impact on savings and investment [Hyung (2013)]. Moreover, as explained by the Solow growth model and endogenous growth models, high population growth has an adverse impact on economic growth [McMahon (1999)]. High population growth leads to higher consumption, which reduces savings and investment [Park and Shin (2011)].

Human capital refers to higher level of education and skills. Therefore, it ensures higher returns from investment and economies of scale, thus helps in accumulation of physical capital stock. Moreover, human capital stock not only helps in generating new capital stock but also improves the absorptive capacity of economy for new technology [Lopez-Bazo and Moreno (2008)]. The impact of exchange rate changes can be explained both as favourable and harmful. For instance, exchange rate affects domestic investment and capital accumulation through cost of capital location. Depreciation in exchange rate accelerates domestic investment as it burgeons the gains from exports. In contrast, it also turns imports expensive which may hamper domestic investment due to higher cost of imported raw material. Therefore, the impact of exchange rate on domestic investment is conditional on the strength of export and import channels.

Finally, we take the product of the coefficients of demographic change indicators from Equation (2) and coefficient of estimated capital stock from Equation (3) to identify the indirect impact of demographic change on economic growth (i.e. $\delta_8 * \gamma_1$). The computation of indirect and total effect is given as follows:

$$\frac{dG_t}{dDV_t} = \frac{dG_t}{dDV_t} + \frac{dG_{it}}{{}_d K_t^{DV}} * \frac{dK_t}{dDV_t}$$

The study covers the time period 1960–2015 and all the data is extracted from World Development Indicators by the World Bank and Penn World Tables (PWT) 9.0. Before carrying out the empirical analysis for the times series data, it is important to test the selected series for the stationarity properties. Amongst various available tests, Augmented Dickey Fuller test (ADF) developed by Dickey and Fuller (1979) is most widely recommended by the existing literature. Therefore, ADF test is used to examine the stationarity properties of the data.

For estimation, the present study employs Fully Modified Ordinary Least Squares (FMOLS) technique to estimate the impact of demographic change on economic growth of Pakistan through the channel of physical capital. FMOLS technique, proposed by Phillip and Hansen (1990), is a semi-parametric approach to co-integration. It is used to estimate the single equation co-integration relationship with the combination of variables that are integrated of order one. FMOLS modifies the conventional least squares to account for the serial correlation and test for endogeneity among the regressors that may arise due to the existence of co-integrating relationships [Rukhsana and Shahbaz 2008].

4. RESULTS AND DISCUSSIONS

The descriptive statistics are presented in Table1. The statistics show that the average population growth is 2.6 percent with a minimum value of 2 percent and maximum of 3.3 percent during the sample period. Among the dependency ratios, average young age dependency remains significantly higher than old age dependency which may be due to high population growth in the country. The average working age population is 54.67 percent of the total population. The highest variation is exhibited by YADR while lowest is observed in OADR. Among macroeconomic variables, GDP shows large variations as compared to investment. Notably, HK in the country is very low as observed from the mean value of HK. The average value of interest rate is 7

percent with a minimum of 2 percent while a maximum of 12 percent. TO and FDI both are considered an important source of technology diffusion and openness. By looking at the average values, we can observe that TO, on average, remains higher than FDI in Pakistan.

Before estimating the final model, the unit root properties are examined and their results are reported in Table A-2 in Appendix. These estimates identify that all the variables are stationary at the first difference and, therefore, are integrated of order one.

Table 1

Descriptive Statistics

Variable	No. of Obs.	Mean	Std.Dev.	Min	Max
GDP	54	28.754	0.8029	27.283	29.949
K	54	27.223	0.589	25.757	28.076
GEGDP	55	11.071	1.773	7.781	16.78
HK	54	1.496	0.271	1.166	2.029
RER	54	4.038	0.448	3.312	4.729
TO	47	32.484	4.287	19.932	38.909
FDI	44	0.757	0.832	-0.063	3.668
DC	54	23.559	4.000	11.148	29.786
PG	54	2.616	0.425	2.028	3.344
OADR	54	7.198	0.133	7.075	7.777
YADR	54	76.101	8.179	54.738	83.048
WAPOP	54	54.668	2.592	52.539	61.794
r	55	7.909	2.732	2.140	12.470

4.1. Direct Impact of Demographic Changes on Economic Growth

The first step of our empirical analysis is to estimate the impact of selected demographic change indicators on economic growth. In this regard, we estimated Equation (1) four times with four different demographic variables. The results of this step are reported in column 2-5 of Table 2.

According to empirical findings, the impact of demographic change indicators, it is observed that two of the three indicators namely old age dependency ratio (OADR) and young age dependency ratio (YADR) affects GDP growth adversely. Notably, the size of OADR is much higher than the YADR. This finding suggests that old age population is more burdening for economic growth of Pakistan. These findings are appealing as expenditures on young age populations are mainly comprised of education expenditures which helps increase the level of human capital stock and ultimately, augments the development process of a country. Increase in young age dependency, though, reduces financial savings but increases spending on human capital. Since at young age people spend more on human capital, therefore, the adverse impact of YADR is less as compared to the OADR [Park and Shin (2011)]. This finding is further supported by Prskawetz, *et al.* (2007) who also explain a negative impact of young age dependency ratio on economic growth. Similarly, Lindh and Malmberg (2009) report a negative impact of age group 65 and above on GDP growth.

Table 2

Direct Impact of Demographic Changes on Economic Growth

Variable	Model 1 Coefficient (S.E)	Model II Coefficient (S.E)	Model III Coefficient (S.E)	Model IV Coefficient (S.E)
K_t	0.247***	0.207***	0.223***	0.192***
	(0.019)	(0.028	(0.014)	(0.054)
$OADR_t$	–0.084***	–	–	
	(0.026)			
$YADR_t$	–	–0.002**	–	
		(0.001)		
PG_t	–	–	0.017***	
			(0.003)	
WAPOP				0.013*
				(0.006)
TO_t	0.078***	0.068***	0.066***	0.079***
	(0.011)	(0.015)	(0.007)	(0.029)
FDI_t	–0.016***	0.004	–0.003*	0.001
	(0.002)	(0.004)	(0.002)	(0.007)
HK_t	0.519***	–1.23***	–0.611***	–1.715***
	(0.079)	(0.235)	(0.081)	(0.499)
CPI_t	0.023***	–0.099***	–0.107***	–0.153***
	(0.008)	(0.020)	(0.009)	(0.039)
C	3.289***	12.254***	12.889***	12.052***
	(0.347)	(1.265)	(0.601)	(0.029)
R^2	0.999	0.999	0.999	0.999

Note: Model I, Model II, and Model III, respectively, display the estimates for the model taking OADR, YADR, PG, and WAPOP as an indicator of demographic change.
***, **, * indicate statistical significance at 1 percent, 5 percent, and 10 percent level of significance, respectively.

The impact of third indicator of demographic change, population growth, however, is positive. This finding explains the fact that higher population growth leads to higher labour force which in turn leads to higher GDP growth. Notably, this positive impact of population growth is less than the negative impact of other two indicators. The optimistic view regarding the impact of population growth on economic growth endorses a favourable impact of population growth on economic growth. For instance, Boserup (1965) argues that increase in population growth creates incentive for innovation and helps in building up human capital thus appears favourable for economic growth. In the similar vein, Gerald and Meier (1995); Kuznets (1960); and Simon (1981) argue that higher population growth leads to building up human capital stock and thus outweigh the adverse impact of the dependency of aging population. More recently, Thuku, *et al.* (2013) and Ali, *et al.* (2013) also evidenced a positive impact of population growth on economic growth. However, Ali, *et al.* (2013) states that higher population growth generates large number of new workforce managing which is challenging for the countries. Trimborn (2012), on the other hand, reports the accelerating impact of

demographic changes on technological progress and economic growth only in medium run. In long run, the countries experience slower growth.

Finally, the working age population, the fourth indicator of demographic changes, accelerates economic growth [An and Jeon (2006); Nguyen (2008); Bloom and Finlay (2009); Choudhry and Elhorst (2010)] since it provides labour force, and also reduces dependency ratio thus ultimately contributes to economic growth [Choudhry and Elhorst (2010)]. On the other hand, increased working age population results in higher productivity growth. Furthermore, higher growth in working age population is referred as the "large-country" effect which implies more number of people involved in productive work [Isaksson (2007)].

Turning towards the impact of other variables, we observe a statistically significant impact of all variables on economic growth. In particular, the estimates reveal that trade openness has statistically significant impact on growth. Trade theories document a significant and positive impact of trade openness on economic growth of a country. Endogenous Growth Theory developed by Frankel and Romer (1999), and Lucas (1998) imply that trade leads to competition, technology transfer and efficient allocation of resources which ultimately foster economic growth. Din, *et al. (*2003) and Umer (2014) document that trade is an important policy instrument and portrays a positive and significant impact on output growth of Pakistan.

In contrast, our findings exhibit statistically adverse impact of FDI on economic growth. The literature such as Borensztein, *et al.* (1998), Mencinger (2003), Omran and Bolbol (2003) also provides evidence for the negative impact of FDI on growth. Human capital signifies a positive impact on economic growth. Empirical studies such as Lucas (1998), Romer (1990), Barro (1991), Barro and Lee (1993) have considered human capital as an important factor in explaining the economic growth. Moreover, inflation rate also exerts a favorable impact on economic growth. The literature has reported both negative and positive impact of inflation on economic growth. This finding of the study supports the argument that inflation generates profit earning opportunities for producers which increases output level. Hussain and Malik (2011) also support this finding. However, Ayyoub, *et al.* (2011) document that inflation is favorable to economic growth only below a certain threshold level and otherwise hurts economic growth.

4.2. Indirect Impact of Demographic Changes on Economic Growth

In order to estimate the indirect impact of demographic changes on economic growth, we proceed as follows: (i) estimate the impact of each indicator of demographic changes on capital stock separately and obtain the series of estimated capital stock. (ii) we use these estimated capital stock series, from the first step, to estimate its impact on growth. This exercise enables us to estimate the impact of each indicator of demographic change variable on economic growth through the channel of physical capital stock. In the following paragraphs, we discuss the findings of both of these steps.

The estimates for the direct impact of each demographic change indicator on capital stock are presented in Table 3. The selected set of regressors entails theoretically expected signs in relation to the capital stock. In particular, for the demographic change indicators, Table 3 reports a negative impact of all the indicators of demographic change on investment. Particularly, the dependency impact measured through OADR and YADR

Table 3

Direct Impact of Demographic Change on Capital Stock

Variable	Model V Coefficient (S. E)	Model VI Coefficient (S.E)	Model VII Coefficient (S.E)	Model VIII Coefficient (S.E)
K_{t-1}	0.552***	1.567***	0.398***	0.035***
	(0.026)	(0.044)	(0.032)	(0.014)
GDP_t	1.505***	2.436***	1.782***	0.509*
	(0.056)	(0.103)	(0.076)	(0.033)
HK_t	0.011	1.244***	1.598***	–1.106***
	(0.143)	(0.369)	(0.231)	(0.074)
r_t	–0.003***	–0.024***	–0.001	–0.006***
	(0.001)	(0.001)	(0.001)	(0.0005)
G_t	–0.014***	–0.032***	–0.011***	0.003***
	(0.001)	(0.002)	(0.001)	(0.0006)
FD_t	0.0004	–0.027***	0.013***	0.001***
	(0.0007)	(0.001)	(0.001)	(0.0004)
FDI_t	0.007**	–0.026***	–0.072***	0.053***
	(0.003)	(0.006)	(0.005)	(0.002)
RER_t	–0.147***	1.025***	–0.099***	–0.0005***
	(0.012)	(0.024)	(0.018)	(0.0001)
$OADR_t$	–0.171***			
	(0.045)			
$YADR_t$		–0.045***		
		(0.002)		
PG_t			–0.031**	
			(0.011)	
WAPOP				0.006*
				(0.003)
R^2	0.990	0.747	0.979	0.992

Note: Model VII, Model VIII, and Model IX, respectively, display the estimates for the impact of OADR, YADR, PG, and WAPOP on capital stock. The time-period for the study is 1960-2015. ***, **, * indicates statistical significance at 1 percent, 5 percent, and 10 percent level of significance, respectively.

decreases investment by 0.17 percent and 0.045 percent, respectively. Once again, the adverse impact of OADR is dominant than YADR. The life cycle theory states that the saving and investment decisions vary with age. For instance, young and old age groups, generally, save less in comparison to the working age group. Therefore, OADR and YADR exhibit a negative impact on investment level. Moreover, an increase in overall dependency ratio decreases the savings of working age group [Kogel (2003)]. The empirical literature also supports the negative impact of dependency ratios on investment such as Hyung (2013) and Kelly and Schmidt (2005) among others. Moreover, Bakshi and Chen (1994) have formulated two hypotheses relating age structures and investment, namely the life cycle investment hypothesis and the life cycle risk aversion hypothesis. The first explains that older people invest more in equities while the latter states that

older people are more risk averse therefore they invest more in equities. Park and Shin (2011) considered that there is a direct relationship between age structure of population and investment.

The adverse impact of population growth on investment is the lowest (-0.03 percent) amongst three of the demographic change indicators. Theories based on Solow growth model and endogenous growth models document an inverse impact of population growth on savings in an economy [McMahon (2001)]. These theories argue that with increase in population, a larger proportion of income is devoted to consumption and less is saved which creates less funds for investment thus lowers the rate of investment. Our finding is in line with these theories and supported by Park and Shin (2011). Similarly, investment-diversion effect explains that public private expenditures are diverted from growth oriented investment to social security projects as a result of high population growth in a country [Kelly and Schmidt (2005). Finally, the impact of working age population on investment is observed as favorable. Working age population boosts savings and thus investment level in the country. According to Bloom and Williamson (1998), a rising growth rate of the working age population lead to decrease in the dependency ratio which increases savings and thus investment level in the country.

Focusing on the impact of other variables, GDP growth positively and significantly affects the capital stock. From the accelerator theory of investment, it is confirmed that an increase in overall output in a country is an indicator of better economic performance of that country, which also attracts more investment [Anwer and Sampath (1999)]. Moreover, human capital signifies a positive impact on physical capital stock. It identifies that higher level of skill and education of workers allows higher returns from investment. Moreover, stock of human capital helps in generating more stock of physical capital as well as higher returns from investment and increased absorption of technology [Lopez-Bazo and Moreno (2008)]. Similarly, FDI helps increasing domestic investment. This implies that foreign investment provides competitive environment to domestic investors which lead to higher domestic investment. We also take interest rate as an indicator of the cost of borrowing to estimate its impact on physical capital stock. The IS-LM framework explains an inverse relationship between interest rate and investment. The estimates of our study suggest that higher cost of borrowing leads to lower investment. This finding is supported by Joshua and Delano (1990) who also explain an adverse impact of interest rate on investment.

The interesting finding that we can report here is that government expenditures crowds out private investment. Pakistan being the developing country faces serious resource constraints, therefore, high government expenditures put upward pressure on demand for loanable funds which makes loanable funds expensive thus lowering down the private investment by increasing the cost of borrowing. On the other hand, financial development appears to improve the channels through which funds are utilised in an economy. A developed financial system provides better financing and hedging opportunities which helps in increasing the investment level. For Pakistan, it is reported that financial development has a favorable impact on investment level. This finding is in line with King and Levine (1993) and Salahuddin, *et al.* (2009).

In order to estimate the impact of demographically induced capital stock on economic growth, we re-estimate economic growth model given in Equation (1) by

replacing capital stock with the estimated capital stock while the other regressors are kept same. These estimates are presented in Table 4. The empirical findings for all the selected regressors are robust as discussed above. Focusing on the impact of demographically induced capital stock on growth, the estimated capital stock, in all the models, show statistically significant and positive impact on GDP growth. Particularly, the magnitude of the impact of capital stock induced by OADR is the highest followed by population growth, YADR, and WAPOP respectively.

Table 4

Impact of Demographically Induced Capital Stock on Economic Growth

Variable	Model IX Coefficient (S.E)	Model X Coefficient (S.E)	Model XI Coefficient (S.E)	Model XII Coefficient (S.E)
GDP_{t-1}	0.321**	0.481***	0.302*	0.351***
	(0.157)	(0.032)	(0.171)	(0.113)
K_t^{OADR}	0.178***			
	(0.065)			
K_t^{YADR}		0.063***		
		(0.014)		
K_t^{PG}			0.151**	
			(0.067)	
K_t^{WAPOP}				0.013*
				(0.007)
TO_t	0.085**	0.108***	0.109**	0.079**
	(0.037)	(0.032)	(0.043)	(0.029)
FDI_t	0.008	0.013**	0.009	0.0009
	(0.005)	(0.006)	(0.006)	(0.007)
HK_t	–0.968**	–0.807**	1.077***	–1.715***
	(0.313)	(0.259)	(0.364)	(0.499)
CPI_t	–0.188***	–0.106**	0.138***	–0.253***
	(0.028)	(0.039)	(0.046)	(0.039)
C	13.882***	12.371***	14.506***	12.053***
	(3.165)	(2.193)	(3.543)	(2.597)
R^2	0.995	0.999	0.996	0.999

Note: Model IV, Model V, and Model VI, respectively, display the estimates for the impact of capital stock induced by the OADR, YADR, PG, and WAPOP on Economic Growth. The time-period for the study is 1960-2015. ***, **, * Indicates statistical significance at 1 percent, 5 percent, and 10 percent level of significance, respectively.

Finally, we compute the indirect impact of demographic change on economic growth. As explained above, we take a product of the coefficient of the impact of each measure of demographic change indicator (δ_8) on capital stock with the coefficient of the estimated capital stock on economic growth (γ_1). These findings are displayed in column 3 of Table 5. This exercise reveals that the indirect impact of demographic change on GDP growth appear as negative in all cases. Interestingly, in accordance with the direct

Table 5

Total Impact of Demographic Change on Economic Growth

Variable	Direct Impact	Indirect Impact	Total Impact
OADR	–0.084	0.178 * (–0.171)	(–0.084) + (–0.030) = –0.114
YADR	–0.002	0.063 * (–0.045)	(–0.002)+ (–0.003) = –0.005
PG	0.017	0.151 * (–0.031)	(0.017) + (–0.004) = –0.013
WAPOP	0.013	0.381 *(0.006)	(0.013) + (0.002) = 0.015

impact, the magnitude of the impact is highest for OADR while lowest for the YADR. These findings suggest that young age dependency is the least harmful demographic change in Pakistan. Though population growth appears as favourable for investment, however, it still has adverse impact on GDP growth. Notably, the working age population pertains a favorable impact, both direct as well indirect, on the economic growth. This indicates the working age population promotes economic growth through both direct as well as indirect channels.

Having done with the direct and indirect impact separately, we now turn to compute the total impact of demographic change on economic growth of Pakistan. In doing so, we take the sum of the above two effects i.e. the direct impact and the indirect impact. These estimates are given in column 4 of Table 5. We observe that the total impact of all the indicators of demographic change appears as negative. The total negative impact is highest in case of old age dependency which means that old age dependency is the most threatening demographic change for economic growth. The least harmful demographic change is the young age dependency.

By comparing the direct and the total impact of demographic change indicators on economic growth, we may also conclude that the total impact while taking the channel of capital stock in consideration, is different from the simple direct impact. For instance, in case of population growth and OADR, the overall impact is lower than the direct impact, through remains negative. Surprisingly, the overall impact of YADR is slightly higher than the simple direct impact. Finally, the impact of working age population remains positive and the size of overall impact is substantially higher than direct impact. This findings provides a cautious conclusion that while discussing the impact of demographic changes on economic growth, it is important to consider the transmission channels through which demographic changes affects economic growth. Hence, the simple direct impact may be either understated/overstated and therefore may lead to misleading conclusions.

5. CONCLUSIONS AND POLICY IMPLICATIONS

Role of demographic changes in determining economic outcomes has been widely studied and there is vast evidence that demographic changes influence economic performance of a country, particularly economic growth. Theoretically, the optimistic, pessimistic and the neutralist view conclude positive, negative and no impact of population growth on economic growth respectively. Over the years, researchers have also pondered on implications of changing age structures for economic development and linked these changing age structures with the transition of fertility and mortality rates and

hence to demographic transition. According to these studies, changes in the age composition of the population in a country are causing demographic transition, which ultimately stimulate or impede economic growth.

Though during the first two stages of demographic transition, birth rates are increasing while death rates are slowly declining but the third stage of demographic transition is specifically important for developing countries. Because the declining fertility and mortality rates offers the opportunity of demographic dividend in the form of increasing ratio of working age population. Pakistan like many other developing countries is currently experiencing an increase in working age population and has the opportunity to use it to achieve broader development goals. Demographic dividend affects the economic performance of a country through increased labour supply, higher savings, and investments in human capital; all of which have considerable positive impact on economic growth. Therefore, there is both the direct and the indirect effect of demographic changes on economic growth. The existing empirical literature has mainly discussed the direct impact of demographic changes one economic growth but few studies has empirically investigated the indirect effect of demographic changes on economic growth through various channels.

This study contributes in the literature on indirect effect of demographic changes and empirically examines the role of one such mediating factor, namely physical capital stock, in the relationship between demographic changes and economic growth for Pakistan over the period 1960–2015. In doing so, four indicators of demographic change namely, population growth, old age dependency ratio, working age population ratio and young age dependency ratio are used. Our empirical analysis is comprised of three steps. In the first step, the direct impact of demographic changes on economic growth is estimated, while, the second step involves the computation of the indirect impact through firstly estimating the direct impact of each demographic indicator on capital stock separately and then analysing the impact of demographically induced capital stock on economic growth. Together, the indirect impact is computed by multiplying the former and the later coefficients. Finally, the total impact is computed by summing the direct and the indirect impacts. The analysis is based on Fully Modified OLS technique.

Results have shown that the direct impact of each indicator of demographic change is different from its indirect effect. Among the focused demographic indicators both, the young age dependency and the old age dependency have an adverse impact on economic growth through direct and the indirect channel. This is worth noting that in size old age dependency has a larger direct and the indirect effect on economic growth. Interestingly, the direct impact of population growth on economic growth is positive but its indirect impact is negative, thus implying that population growth reduces physical capital through decrease in savings. However, the working-age population ratio is increasing economic growth through its both direct and indirect impacts.

The larger size of total impact compared to the direct impact points towards the importance of studying the mediating role of physical capital in determining the impact of demographic changes on economic growth, without which the results may be misleading. The previous works tend to downplay the effect of population growth on economic development, which does not prescribe the requisite urgency to the situation in Pakistan.

First of all the direct impact of old age dependency is more pronounced when compared with other indicators of demographic change. This lays focus on insufficiency of publically provided safety nets for the elderly, putting the burden of their care squarely on the shoulders of the working age population. Resultantly not only we see that the impact of old aged dependency is quite high but also the coefficient of working age population ratio is quite small. Further, the time cost of caring for the elderly is also a factor that may render a significant portion of the working age population unable to participate in the labour market, leading to reduced impact on economic growth. This signifies the need for government assistance in the form of not only pensions but also subsidised healthcare provisions. Further, facilitation for labour force participation in the form of subsidised at-home care facilities may also be in order.

The comparison of direct and indirect impact of population growth signifies that the direct impact in itself may be misleading but once assessed through its negative influence on capital stock the problem becomes more pronounced. This signifies the need to cater for the population explosion and its adverse impact through reducing birth rates. This can be done by not only facilitating and encouraging use of contraceptives and family planning but also by increasing the opportunity cost of bearing children. One way to do that can be through instituting compulsory universal education, facilitating female labour force participation, penalising negligent parenthood and child marriages. Most of these are already part of the current policy framework of the country but our results demonstrate gross implementation gap.

Finally, Pakistan right now has the opportunity to capitalise on a bulging working age population but it is being squandered due to various other considerations. Only by allotting due priority to the issue will the government be able to derive the potential benefits from a fortuitous situation.

Given the results of the study and the population census 2017, Government should devise effective policies to reduce population growth, which resultantly will reduce young age dependency ratios. Moreover, to reap the benefits of increasing working age population ratio in the form of higher economic growth, more employment opportunities should be created.

Table A-1

Summary of the Literature Review

Author	Study Objective	Sample/Period	Results
Malmberg (1994)	Analyse the impact of age structures on economic growth and sources of growth	Sweden/ 1950-89	Shifts in age structure explain Swedish economic growth and there exists hump shaped relationship between age groups and savings
Barro (1991)	Analyse the impact of economically active population on income growth	98 countries/ 1960-85	Growth rate of economically active population has positive impact on real GDP per capita growth
ADB (1997)	Analyse the impact of economically active population on income growth	East and South East Asian Countries/ 1965-92	Growth rate of economically active population has positive impact on income growth
Bloom and Williamson (1998)	Study the impact of demographic variables on economic growth through accounting effect and behavioral effect	78 countries/ 1965-90	Growth rates of population and working age population has respective negative and positive impacts on GDP per capita growth. While population under 15 is also having negative impacts on income growth
Bloom, *et al.* (2001)	Study the relationship between the economic growth and the Demographic transition by focusing on various regions	Case studies of population change and growth for East Asia, Japan, North America and Western Europe, South-central and Southeast Asia	East Asian miracle can be explained by the demographic transition of East Asian countries
Kelley and Schmidt (2005)	Focuses on population's role in economic growth by developing a model for output per worker growth	1960-95, 86 countries	Declining births and declining deaths have contributed to rise in per capita income growth across the World, specifically, in Asia and Europe.
Prskawetz, *et al*. (2007)	Impact of working age population ratio and youth dependency ratio on growth rate of output per worker	1965-90, 97 countries	Changes in age structures have important effects on economic growth
Lindh and Malmberg (2009)	Relationship between age structures and economic growth in EU15 countries	EU 15 countries, 1950-2004	Variations in the age distribution of the population has significant effect on economic growth and a hump shaped relationship exist between the two variables
Choudhry and Elhorst (2010)	Analyse the impact of age dependency ratios on per capita income growth	70 countries/1961-2003 and Pakistan	negative impact of old and child age dependency ratios on per capita income growth in cross-country analysis, while, population dynamics explain 25 percent of changes in per capita GDP growth in Pakistan

Continued—

Table A-1—(*Continued*)

Hussain, *et al.* (2009)	Impact of demographic variables on economic growth	Pakistan/1972-2006	infant mortality rate and total fertility rate are having a negative impact on GDP growth
Iqbal, *et al.* (2015)	Relationship between demographic transition and economic growth in the short and long run	Pakistan/1974-2011	positive impact of demographic transition on economic growth in the long-run but negative impact in the short-run
Park and Shin (2011)	relationship between population ageing on savings, capital accumulation, labour force participation and total factor productivity	12 Asian economies/1981-2010	Positive relationship between population growth and savings and in future population ageing will have adverse impact on economic performance
Asongu (2011)	Relationship between population growth and investment dynamics	Individual time-series analysis of African countries and for 38 African countries/1977-2007	In the long-run population growth has significant and sizeable effects on different types of investments: it can sometimes decrease or increase foreign, public, private and domestic investments in different countries.
Goyal (2004)	Relationship between population age structure and net outflows from the stock market and stock market returns	US/1926-198	Outflows are positively related with proportion of old age people and changes in proportion of middle age population negatively affect the outflows.
Batini, *et al.* (2006)	Impact of demographic transition over the next 80 years	US, Japan and other industrial and developing countries	In advanced countries, population ageing will reduce per capita income growth while, in developing countries increase in working population can increase per capita income growth. Demographic variables have strong effect on savings, investment and capital flows
Bosworth and Chodorow-Reich (2006)	Relationship between population ageing and savings and investment	85 countries/1960-2005	Significant impact of population ageing on national rates of saving and investment but impact is different for different countries

Table A-2

Estimates of Unit Root Test

Variable	Level	1st Diff	Decision
GDP	–0.700	–6.260	
	(–3.497)	(–3.498)	I(1)
GFCF	–1.938	–4.494	
	(–3.498)	(–3.500)	I(1)
LEMP	0.626	–7.526	
	(–2.921)	(–2.922)	I(1)
	–2.456	–7.736	
TO	(–2.926)	(–2.928)	I(1)
FDI	2.527	–5.309	
	(–2.951)	(–2.945)	I(1)
LRER	–1.125	–6.462	
	(–2.917)	(–2.919)	I(1)
GFCF_OADR	–2.500	–4.158	I(1)
	(–2.945)	(–2.935)	
GFCF_PG	–2.524	–4.521	I(1)
	(–2.935)	(–2.935)	
GFCF_YADR	–2.103	–3.983	I(1)
	(–2.935)	(–2.935)	
IR	–2.547	–7.218	I(1)
	(–2.916)	(–2.917)	
LCPI	0.069	–3.348	I(1)
	(–2.919)	(–2.919)	
GEGDP	–1.989	7.118	I(1)
	(–2.916)	(–2.917)	
POPG	–1.595	–1.697	I(1)
	(–2.919)	(–1.948)	
OADR	–2.188	–3.781	I(1)
	(–3.498)	(–3.500)	
YADR	–0.555	–2.391	I(1)
	(–1.947)	(–1.948)	
WAPOP	–2.279	–2.941	I(1)
	(–2.924)	(–2.925)	
DC	–2.541	–6.098	I(1)
	(–3.508)	(–3.499)	

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